Land and people : Finding a Balance

Los Angeles

U.S. Department of the Interior
U.S. Geological Survey

Introduction

The La Crescenta project in this curriculum packet asks students to consider the following Focus Question: You and your classmates are members of a La Crescenta civic group that has been formed to evaluate the safety of your community's school children in the event of the following geologic and hydrologic hazards: earthquakes, and landslides (including mud and debris flows). Using the maps, tables, and other information in this packet, your job is to present the study of geologic hazards to children that attend the following schools: Monte Vista School, Valley View School, and Rosemont Junior High School. Once your group has discovered what the hazards are, you will decide whether school children are safe attending the three schools in their present locations, or new sites for the schools must be found. Your group will make a presentation at a La Crescenta "community meeting" in which you will describe your analysis about how the community can guarantee children's safety during school.

To develop an answer to this complex question, students will:

- explore the unique geology of the Los Angeles area,
- study the area's natural hazards and explore how human impact on the environment increases the effects of these hazards, and
- learn how to use a variety of maps (geologic, topographic) to answer questions about safety risks.

At the end of this project, students should produce a presentation or paper that they will share with the class. Their presentation will discuss what they believe are the most serious geologic and hydrologic hazards in the La Crescenta area, how those hazards affect school children, and whether the schools should be left where they are, closed, or relocated. They will provide justification for their analysis, based upon the information they received in the Student Packet, their understanding of geologic and hydrologic hazards, and the lessons they learned as they completed the three activities in this packet.

Activity 1
Sand Castles

Purpose

The 'sand castles' activity will help students understand slope stability and how adding water to earth materials affects slope stability.

Materials

Each group of students will need:

- One 1/2-gallon plastic bottle filled with dry sand,
- One plastic gallon-size tub,
- One foam cup with holes punched in the bottom (use a paper clip as a hole-punch),
- One graduated cylinder or measuring cup (something to measure the volume of water used during the activity),
- One ruler or yardstick, and
- One protractor with a piece of string and a small weight (or contact goniometer if available — used to measure the angle between mineral crystal faces).

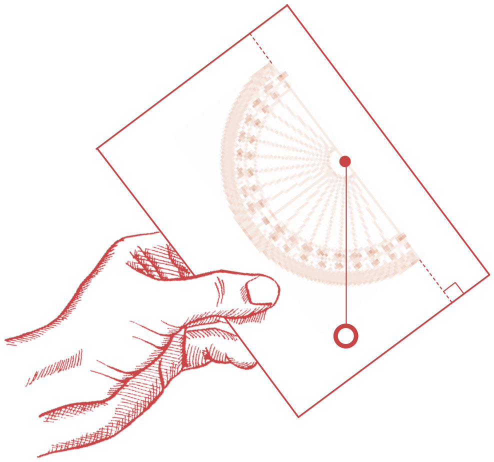
Procedure

1. Ask each group of students to build a sand castle in the plastic tub by using all the sand in the bottle. How tall can they make their castles? Encourage them to try different options with the dry sand, such as building the castle in the middle or against the side of the tub. Have them discuss the problems they encounter trying to build the tallest castle possible.

2. Once they have experimented for several minutes, have the students measure the height of their castles with the ruler. Make sure students measure from the base of the castle to its tallest point, not the length of its slope. Have students report their measurements to the class.

3. Have students brainstorm about how they might measure the slope angle. To measure the slope angle, students can construct a simple clinometer by using a protractor, a piece of string and some small weight, such as a nut or small bolt. Thread a weighted string (the string should be at least the same length as the straight edge of the protractor) through the pencil hole in the protractor. Glue the protractor to a piece of cardboard as shown in the illustration. Place the straight edge of the cardboard on the slope to be measured and read the angle of slope on the protractor scale. Have students record the slope angle.

4. Challenge students to suggest ways they can make their castles higher. Invite them to think of any means possible, even using materials other than sand. Students may suggest such methods



Make your own clinometer by gluing a protractor to a piece of cardboard, then threading a weighted string through the center. Your clinometer will help you measure slope angles as you build sand castles and models in these activities.

as building walls, bracing the sand, adding water to the sand, and adding other materials to the sand. Record these suggestions on chart paper so students can refer to them later.

5. Have the students add water to the sand and, again, try to build a sand castle. Let them experiment until they are satisfied they have the highest possible castle. Collect height measurements from each group. Discuss the results of this second attempt to build the castle, then compare the wet sand castle heights to the dry sand castle heights. Have students calculate the average height of the dry sand castles and the average height of the wet sand castles.

6. Ask, "Why do you think the wet sand castles are higher?" Students will realize that wet substances have different properties than dry ones. Ask students to think of other instances in which adding moisture changed the property of a dry substance, such as adding milk to flour when baking.

7. Ask students what they think will happen if they add more water to their sand castles. Suggest that the groups 'rain' on their castles by filling the perforated Styrofoam cups with water and then letting the water rain on the castle. They should fill the perforated cups with 100 mL of water at a time so they can easily record the amount of water that caused the castle to slump.

8. Have the groups observe how their castle changes as it becomes wetter. Students should describe these changes in their lab notebooks, as well as the amount of water they rained on the castle.

9. Initially, the changes in the sand castles will be subtle. At some point the sand castle will slump, causing a landslide. When all of the sand castles have slumped, gather the class together to discuss their observations. Ask students how much water they had poured on the castle when it began to look like a liquid instead of a solid. Ask them where the castle failed first—the top, bottom, or middle?

Discussion

This activity is an excellent way to introduce concepts, such as erosion, geologic and hydrologic hazards, mass movements of earth materials (landslides) and water-earth interactions. Gravity provides the energy for landslides, but water also plays a number of roles. Small amounts of water added to the sand increase the cohesion of the sand grains — surface tension — as the water begins to fill pore spaces between the sand grains. As more water is added to the sand castle during the student-generated rain storm, the pore spaces fill with water and the force of the water actually pushes the sand grains apart, causing a landslide. Dry materials, such as sand, have a threshold of slope stability related to gravity and the cohesion of the material. Known as the angle of repose, this threshold limits the height of the castle for a given volume of sand.

Extension

- Discuss how the sand castles could be designed to prevent them from slumping. Ask students what methods they have observed of preventing walls from slumping. They might recall seeing retaining walls or terraces along rivers, streams, or highways.
- Build castles using other earth materials, then compare the height of these castles to the sand castles. Students can bring samples of soil from home.
- Explore how the rate of water flow affects erosion.

Activity 2
Creating a Topographic Model

Purpose

Students often have difficulty visualizing topography from two dimensional contour maps. In this activity, students will build a topographic model of Shields Canyon and the area south into La Crescenta. They will be able to see and feel the steep slopes in the area and the sharp change in topography from the San Gabriel Mountains to the nearly flat valley where the population is concentrated.

Materials

Each group will need:

- Topographic map of model area (Teacher Packet page 4),
- Thick cardboard boxes,
- Scissors,
- Tracing paper, and
- Glue.

Procedure

1. Begin by deciding what kinds of models the students will create. They could work in groups to construct models by using different vertical exaggerations (2:1, 4:1, 1:1) or, you may want to divide the map into smaller areas and have each group construct a model

of an area. After constructing the individual models, students would then assemble the models and create a model of the entire area.

You may want to invite your students to devise their own method of making a three-dimensional representation of the area. They may want to use modeling clay, Styrofoam, or sheets of acrylic. The model-making activity explained below uses heavy cardboard.

2. After deciding what area students will create a model of, explain the model-building process to the students. They will begin by tracing the outlines created by individual contour lines, starting with the lowest elevation. Using the traced shape as a template, students will then cut out cardboard to match the shape. Students will trace each subsequent (and higher) contour, reproduce the shape in cardboard, and stack it on top of the last cardboard shape. Students should glue each piece in place. They will need to refer to the topographical map to see how to place each layer of cardboard.

3. Once they have built the models, have the students compare the topographic map to their model. Comparing the model to the map will help students see that when the topography is steep, the contour lines are close together. When the topography is relatively flat, the contour lines are far apart. Ask students if the model surprises them in any way. Ask students to focus on the Shields Canyon area. Can they now see why in Shield's Canyon the contour lines make upside down v's.

4. Ask students a variety of questions that will help them interact with the model. Have them place markers on the map to represent the schools in the focus question. Ask them to indicate the necessary path of a debris flow.

5. Have students locate the debris retention basins on their models. Ask students to consider the following questions:

- Why were the basins placed where they are?
- What areas do the basins protect?
- What developed areas are not protected by a debris-retention basin?

6. Have students measure the slopes in their model area by using the clinometer they constructed in Activity 1 or a contact goniometer. How do the slopes in the model compare with the slopes of their sand castles? If the slopes in the model are steeper than the ones in the sand castle, ask students to explain why.

7. Display the models prominently during this unit. Have students refer to the models as they answer the Focus Question.

Extension

- Students could construct a series of topographic profiles, which are perpendicular, then connect the profiles.
- Students could pick new sites for debris retention basins that would protect development upstream, from existing basins.

Activity 3
Determining Earthquake-Induced Landslide Potential

Purpose

In this activity, students will use a geologic map of the La Crescenta area and slope inclination data, which are derived from the topographic map and their topographic model, to determine the possibility of earthquake-induced landslides in the region.

Materials

Each group of students will need:

- Geologic map of the Sierra Madre Fault Zone (Student Packet page 8),
- Topographic map (Student Packet page 7) and student-made topographic model,
- Table: Geologic environments likely to produce earthquake-induced landslides in the Los Angeles region (Student Packet page 6) (adapted from USGS Professional Paper 1360), and
- Table: Standard size classes of sediment.

Procedure

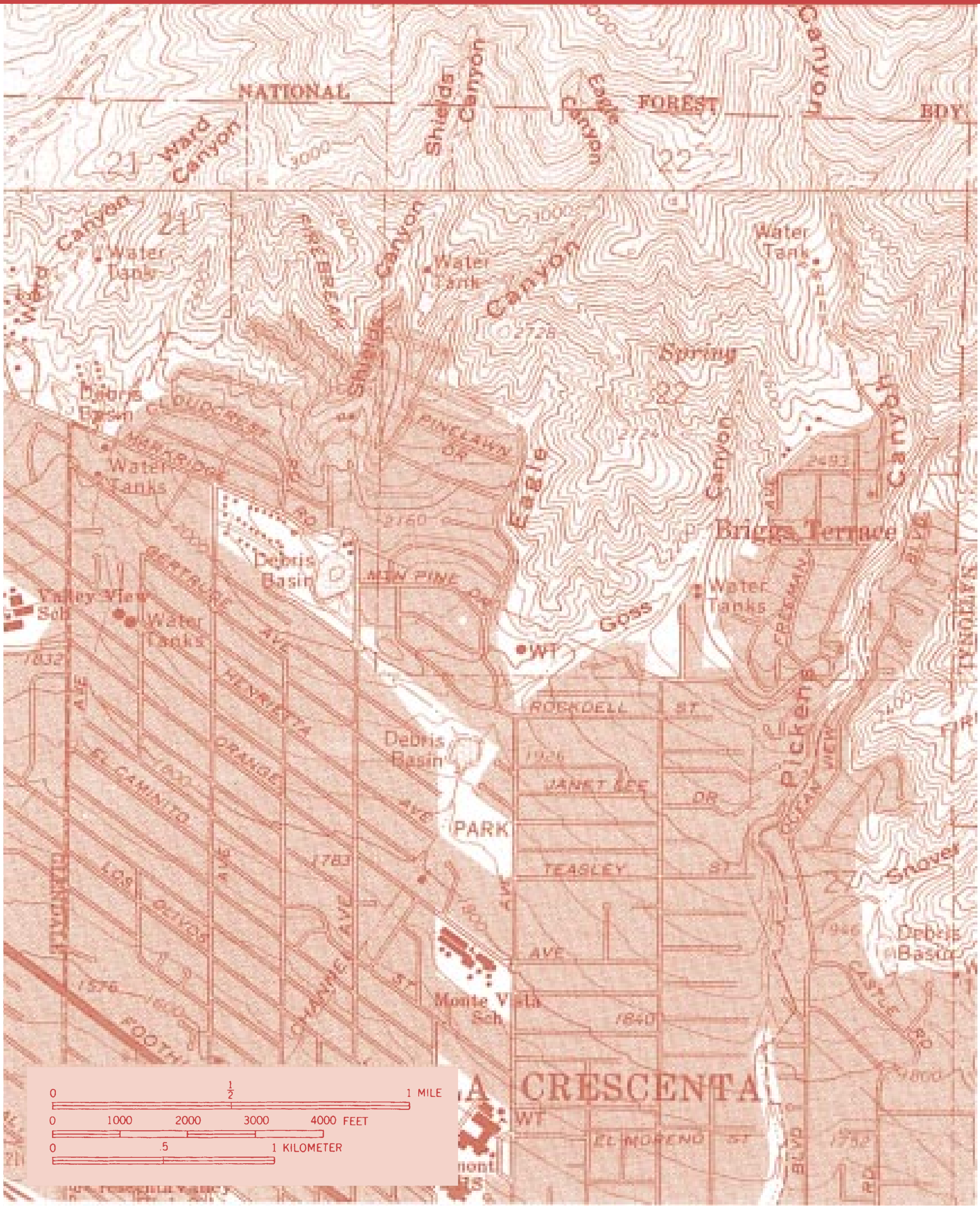
1. Provide students with copies of the materials listed above. Briefly explain to students what kind of information each of the materials (tables, model, maps) contains. For example, explain to students that a geologic map shows what materials are exposed at the surface.

2. Have students study the geologic map and the two tables. Ask students to locate the geologic environments listed in the table on the map.

3. Discuss the sediment-size table with the class. Explain that the table shows how geologists classify large and small sediments. Consider bringing in samples of the smallest sediments and creating mock pebbles, cobbles, and boulders out of wadded newspaper or paper-filled trash bags.

4. Have students use the tables, geologic map, and topographical model to answer the following questions about slope, geologic materials, and the risk of earthquake-induced landslide: Where is the landslide hazard the lowest? Where is the hazard the highest? What kinds of landslides are likely to occur in this region?

5. Have students mark the topographic map "Highest Landslide Risk," etc., as they answer these questions in Step 4.



Topographic map of model area (Activity 2). Create your own landslide hazard map. Use this topographic map to mark locations where you believe landslide risk is high or low.

6. Present students with the following scenario: It's February 1998. There's been an earthquake along the Sierra Madre Fault, magnitude 7.0 on the Richter scale. Have students find the Sierra Madre Fault on the geologic map. Then ask them to identify the locations where earthquake-induced landslides are likely to occur.

7. To connect this extended map interpretation activity to the Focus Question, ask students, "Based on the information in the geologic environments table, what can you predict about the potential for earthquake-induced landslides in the La Crescenta area?"

Extension

Students could predict what would happen in the La Crescenta region if an earthquake occurred right after a heavy rain.

Students could develop a susceptibility map and use it to answer the Focus Question in their final presentations.